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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Fufang Zha et al.
Serial No:	10/537,760
Confirmation No:	5173
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Title:	MIXING CHAMBER
Examiner:	Menon, Krishnan S.
Art Unit:	1777

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8(a)

The undersigned hereby certifies that this document is being electronically filed in accordance with § 1.6(a)(4), on the 1st day of February, 2011.

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Commissioner for Patents

APPELLANT'S REPLY BRIEF PURSUANT TO 37 C.F.R. § 41.41(a)(1)

Dear Sir:

This Reply Brief is submitted in response to the Examiner's Answer mailed December 2, 2010 in the above-referenced application.

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I. Reply Brief Identification

Appellant:	Fufang Zha et al.
U.S. Serial No..:	10/537,760
Filing Date:	February 27, 2006
Title:	MIXING CHAMBER
Examiner:	Menon, Krishnan S.
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II. STATUS OF CLAIMS (37 C.F.R. § 41.37(c)(1)(iii))

Claims 1-53 were pending in the application as filed on June 6, 2005. Claims 1, 3-10, 12, 14-22, 29, 32, 34, 40-43, 45, and 47-49 were amended in a Preliminary Amendment filed June 6, 2005. Claims 23-34, 36-39, and 49-53 were withdrawn in an Amendment filed on February 11, 2008. In a Response filed on May 15, 2008, no claims were amended. In an Amendment filed on December 30, 2008, claims 1-9, 12-22, 35, and 40-48 were amended. In an Amendment filed on March 13, 2009, claims 1, 12, 35, 40, and 41 were amended and claims 4, 5, 15, and 16 were canceled. In an Amendment filed on September 21, 2009, claims 1, 12, 35, 40, and 41 were amended and claims 7, 8, 18, and 19 were canceled. In an Amendment filed on January 19, 2010, claims 1-3, 6, 9-12, 35, 40, and 41-48 were amended. In a Response filed on May 11, 2010, no claims were amended. In a Response filed on July 9, 2010, no claims were amended. Claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 currently stand rejected, with claims 1, 12, 35, 40, and 41 being in independent form. Claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 are being appealed herein.

III. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL (37 C.F.R. § 41.37(c)(1)(vi))

Whether each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 are unpatentable over the combination of U.S. Patent Application Pub. No. 2005/0006308 (hereinafter "Cote '308"), claiming priority to U.S. Provisional Patent Application No. 60/278,007 to Cote et al. (hereinafter "the Cote Provisional") and U.S. Patent Application Pub. No. 2001/0047962 to Zha et al. (hereinafter "Zha"), whether each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 are unpatentable over the combination of Zha and U.S. Patent No. 5,482,625 to Shimizu (hereinafter "Shimizu") as further evidenced by Cote '308, and whether each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 are unpatentable over the combination of Zha and/or Cote '308 in view of Shimizu, and further in view of U.S. Patent No. 5,783,083 to Henshaw (hereinafter "Henshaw").

IV. ARGUMENT (37 C.F.R. § 41.37(c)(1)(vii))

For the reasons provided below, the Examiner's rejections are improper and should be reversed. Each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56, as presented, is allowable.

A. Each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 is patentable over the asserted combination of Cote '308 in view of Zha

1. Cote '308 in view of Zha fails to teach each and every element of the present claims

The Examiner appears to have accepted Appellants' previously presented argument that the disclosure of Cote '308, which is not supported by the Cote Provisional, is not prior art with regard to the present application. In the Examiner's Answer, the Examiner relies on the disclosure of the Cote Provisional rather than Cote '308 for support for the rejections of the claims of the present application. The asserted combination of the Cote Provisional in view of Zha, however, fails to disclose or suggest multiple elements of each of the claims of the present application, and thus cannot render any of these claims obvious.

i. Claim 1

The asserted combination of the Cote Provisional in view of Zha fails to disclose or suggest at least the elements of (1) "A membrane filtration apparatus comprising . . . a single manifold coupled to [a] lower header of each of [a] plurality of membrane filtration modules," (2) "a single chamber positioned below, and connected to, said manifold, said chamber constructed and arranged to promote upward flow of feed liquid therethrough" and (3) "a single gas inlet constructed and arranged to introduce gas into said chamber in a downward direction from above the open base end, said gas fed from above and through said manifold and into said chamber" recited in independent claim 1.

In the Examiner's Answer, at, for example, page 6, the Examiner appears to assert that a combination of FIG. 8A and FIG. 1 of the Cote Provisional would result in "a single manifold coupled to [a] lower header of each of [a] plurality of membrane filtration modules; and a single chamber positioned below, and connected to, said manifold, said chamber constructed and

arranged to promote upward flow of feed liquid therethrough" as recited in independent claim 1 because "This air distributer [of FIG. 8A] can be replaced with box 2 of fig 1, as intended in Cote disclosure (paragraph 0005)." (Examiner's Answer at page 6.) Such a replacement of the air distributer of FIG. 8A is not, however, suggested in the Cote Provisional, let alone "intended" in the disclosure. The portion of the Cote Provisional which the Examiner cites as allegedly providing this suggestion discloses that FIG. 8A is only provided to describe a cyclic air distribution system disclosed in another application, which could be used in combination with the embodiments disclosed in the Cote Provisional. (Cote Provisional at paragraph [0005].) There is no suggestion in this or any other section of the Cote Provisional that the multiple air distributers 238 of FIG. 8A should, or even could, be replaced by the air box 2 of FIG. 1.

As previously discussed in both Appellants' Response filed July 9, 2010, and in Appellants' Appeal Brief, the Cote Provisional discloses that only a single membrane module (membrane assembly 1) is associated with a single mixing chamber (air box 2). (Cote Provisional at paragraphs [0010] and [0012] and FIG. 1). The Cote Provisional fails to disclose or suggest how the disclosed membrane module could be combined with other membrane modules, mounted together with these other membrane modules in a single manifold, or provided with a single chamber positioned below and connected to the manifold for the provision of feed liquid as claimed in independent claim 1. One of ordinary skill in the art would thus have believed that to provide a filtration system including a plurality of membrane modules according to the Cote Provisional, each membrane module would be provided with its own air box.

The Examiner continues to assert the flawed argument from the Final Office Action that the Cote Provisional renders obvious the "plurality of membrane filtration modules" mounted by their lower headers to a single manifold above a single mixing chamber as recited in claim 1, because "having a plurality of modules in one module [*sic*] would be only replication of the one module installed in the manifold, which is not a patentable limitation." (Examiner's Answer at page 25.) In maintaining this assertion, the Examiner appears to have ignored or failed to understand Appellants' argument, previously presented in Appellants' Appeal Brief, that the claimed invention is not simply the "replication of the one module." A "replication of the one module" from the Cote Provisional, would comprise multiple filtration modules, each module including its own mixing chamber and air inlet. In contrast, claim 1 recites multiple filtration modules mounted above a single mixing chamber and supplied with aeration gas from a single

gas inlet. This avoids the disadvantages of having to provide additional piping and multiple mixing chambers that would be present in a system where the filtration module of the Cote Provisional was simply replicated.

The Examiner has not identified anything in the Cote Provisional which discloses or suggests the claim element "a single gas inlet constructed and arranged to introduce gas into said chamber in a downward direction from above the open base end, said gas fed from above and through said manifold and into said chamber" recited in independent claim 1. On page 9 of the Examiner's Answer, the Examiner asserts that the Cote Provisional discloses "a single gas inlet (3) with downward flow direction the open base end [*sic*], and the gas is fed from above through the manifold (air pipe directs air downward from above)." The air pipe 3 of the Cote Provisional is not, however, "fed from above and through said manifold and into said chamber." As Appellants have previously explained, the air pipe 3 of the Cote Provisional is not shown or described as entering the air box 2 "from above and through" the air box, but rather enters the air box 2 from a side thereof. The air pipe 3 thus provides more hardware in the flow path of fluid through the air box than does the recited air inlet, and would thus increase the flow resistance of fluid directed toward the membranes as compared to the recited air inlet.

The Examiner asserts that the Cote Provisional discloses two modules with a gap therebetween and that this gap forms a distribution aperture. (Examiner's Answer at page 8.) The Examiner asserts that this disclosure of the Cote Provisional comprises "a plurality of membrane filtration modules, each membrane filtration module comprising . . . a plurality of distribution apertures defined in said lower pot [in which the lower ends of a plurality of fiber membranes are mounted], said distribution apertures configured to distribute a scrubbing fluid into said module and along a surface or surfaces of said membranes" as recited in independent claim 1. Even if what the Examiner asserts is described in the Cote Provisional were accurate, however, the Cote Provisional would not disclose or render obvious this claim element. The disclosed gap is, as the Examiner acknowledges, between membrane modules, not "defined in a lower pot" of a membrane module as claimed.

ii. Claims 12, 35, 40, and 41

The Examiner does not separately address any of independent claims 12, 35, 40, or 41 in either the Final Office Action or the Examiner's Answer. These claims are patentable over the

Cote Provisional in view of Zha for at least similar reasons as independent claim 1, discussed above.

For example, independent claim 12 recites a plurality of membrane modules having lower headers coupled to a manifold. The lower pots of the plurality of membrane modules include a number of distribution apertures therein. A chamber positioned below and connected to the manifold includes a gas inlet constructed and arranged to introduce gas into said chamber in a downward direction from above the open base end, said gas fed from above and through said manifold. As discussed above, none of these elements are disclosed or suggested by the Cote Provisional in view of Zha.

Independent claim 35 recites a membrane filtration apparatus comprising a gas source positioned within an open-ended mixing chamber, the gas source constructed and arranged to introduce gas through a single gas inlet into the open-ended mixing chamber, said gas fed from above and through said manifold and into said chamber. For the reasons discussed above, at least this element of independent claim 35 is not disclosed or suggested by the Cote Provisional in view of Zha.

Independent claim 40 recites a membrane bioreactor comprising a gas inlet positioned within an open-ended mixing chamber coupled to a manifold supporting the lower potting head of a plurality of membrane modules, the gas inlet configured to feed gas into the open-ended mixing chamber from above and through said manifold. Independent claim 40 further recites that at least one of said potting heads includes an array of openings formed therein in fluid communication with said chamber. As discussed above, these elements are not disclosed or suggested by the Cote Provisional in view of Zha.

Independent claim 41 recites an assembly of membrane modules for use in a membrane bioreactor comprising a gas inlet positioned within an open-ended mixing chamber positioned below the lower potting head of a plurality of hollow membrane fibers, the gas inlet spaced from and surrounded by side walls of the open-ended mixing chamber, and centrally located within the open-ended mixing chamber and configured to feed gas into the open-ended mixing chamber from above and through said manifold. The potting heads are configured to provide a number of distribution apertures therebetween in fluid communication with said chamber for providing gas bubbles within said assembly of membrane modules. As discussed above, these elements are not disclosed or suggested by the Cote Provisional in view of Zha.

2. Cote '308 and Zha are not properly combinable *ab initio*

The Examiner has failed to establish that Cote '308 (or the Cote Provisional) may be properly combined with Zha. The Examiner provides a conclusory statement, without supporting reasoning on page 12 of the Examiner's Answer that "It would have been obvious to one of ordinary skill in the art at the time of invention to combine the teachings of Zha and Cote to arrive at applicant's invention as taught by Zha because of the advantages of the Cote air distribution system (see Cote Provisional at paragraph 0021: benefits), with its advantages of the cyclic low and high flow of air) [*sic*] with the Zha design providing improved air scrubbing and removal of accumulated solids at the potted ends without significant loss of packing density (see Zha, paragraphs 0012, 0055 and 0062)." The Examiner further makes the speculative assertion on page 23 that "the stoppage of water or air flow through the venturi [of Zha] would cause dirt to settle in the venture [*sic*] nozzle that could block air and water flow. A downwardly directed nozzle, such as taught by Cote or Shimizu, would prevent this blockage." The Examiner appears to believe that the only difference between the venturi system of Zha and the air injection system of the Cote Provisional or Shimizu is that the venturi of Zha includes an upwardly facing nozzle (see Examiner's Answer at page 22 -23: "it is the air that is admitted through the nozzle that propels the water upward along with the air flow.") This reflects a misunderstanding by the Examiner of how a venturi device operates. A venturi device operates by "entraining said gas bubbles into said liquid medium by flow of said medium past a source of said gas" (Zha at paragraph [0008]), which is a fundamentally different mechanism than entraining gas into a liquid medium using a gas blower as in the Cote Provisional or in Shimizu.

The Examiner has failed to address the fact that Zha acknowledges that gas may be injected by means of a blower "into a liquid system where a membrane module is submerged to form gas bubbles" as is disclosed in the Cote Provisional (and in Shimizu, discussed below), however criticizes such a method and discloses that such a method gives rise to numerous disadvantages which are alleviated through the use of a venturi device instead of an air blower. (Zha at paragraphs [0004], [0041], [0045], and [0046].)[1] To replace the venturi system of Zha with the gas delivery system of the Cote Provisional

[1] These methods "consume[] large amounts of energy, possibly form[] mist or froth flow reducing effective membrane filtration area, and may be destructive to membranes. Moreover, in an environment of high concentration of solids, the gas distribution system may gradually become blocked by dehydrated solids or simply be blocked when the gas flow accidentally ceases." (Zha at paragraph [0004].) "If the gas is directly injected into a pipe filled

would alter the fundamental operating principle of Zha's venturi system and would negate the disclosed advantages of the system. For at least these reasons, one of ordinary skill in the art would thus have been dissuaded from making the asserted modification to Zha.

Accordingly, because each element of each of any of independent claims 1, 12, 35, 40, or 41 is nether disclosed nor suggested by the asserted combination of the Cote Provisional in view of Zha, and because these references are not properly combinable *ab initio*, none of these claims, or the claims that depend therefrom can be obvious over the Cote Provisional in view of Zha.

B. Each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 is patentable over the asserted combination of Zha in view of Shimizu and further evidenced by Cote '308

1. Zha in view of Shimizu and further evidenced by Cote '308 fails to teach each and every element of the present claims

i. Claim 1

In the rejection of independent claim 1 over Zha in view of Shimizu and further evidenced by Cote '308, the Examiner asserts that because FIG. 1 of Zha shows one module, having more than one module attached to a common manifold would be obvious because "mere duplication of the essential working parts of a device involves only routine skill in the art." (Examiner's Answer at page 13.) This argument fails for the same reason as the similar argument presented in the rejection over the Cote Provisional in view of Zha fails. Notably, the Zha module includes a single membrane module supplied with an aerating gas from a single venturi device located in a single chamber associated with the single module. Zha does not disclose or suggest any way in which a plurality of the disclosed membrane modules could be mounted together in a common manifold and supplied with a gas from a single mixing chamber including a gas inlet passing downwardly through a manifold and positioned in the mixing chamber. In contrast to what is recited in independent claim 1, a "duplication of the essential working parts of the device" of Zha would comprise multiple filtration modules, each module including its own air inlet, venturi device, and mixing chamber.

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with a liquid, it is possible that the gas will form a stagnant gas layer on the pipe wall and therefore gas and liquid will bypass into different parts of a module, resulting in poor cleaning efficiency." (Zha at paragraph [0046].)

The Examiner asserts that FIG. 9 of Zha discloses a plurality of modules with a plurality of gaps between the headers. (Examiner's Answer at page 13.) Zha, however, describes FIG. 9 as disclosing a single module (Zha at paragraph [0059].) The Examiner points to a portion of Appellants' specification which the Examiner asserts defines a "module" such as to include one of the individual bundles of membrane filtration fibers illustrated in Zha FIG. 9. This reflects a misreading of Appellants' specification. There is nothing in Appellants' specification that describes that each of a plurality of bundles of membrane filtration fibers mounted between separate headers together in a single enclosed structure (as in Zha FIG. 9) may be considered individual modules. The individual fiber bundles enclosed in the screen 51 of Zha FIG. 9 cannot be considered individual membrane modules either in light of Zha's description thereof or in light of Appellants' specification.

The Examiner further asserts that Zha discloses that the modules of FIGS. 9 or 10 may be attached to appropriate manifolding, and thus would constitute the plurality of modules recited in independent claim 1. Independent claim 1, however, recites that the mixing chamber is positioned below the recited manifold. If the modules of Zha FIG. 9 or FIG. 10 were put in a manifold with other modules, the mixing chamber (the portion including the jet assembly 57) would then be positioned above the manifold, not below.

On page 14 of the Examiner's Answer, the Examiner asserts that, like the Cote Provisional, Shimizu teaches a downwardly facing air inlet in a submerged membrane system. The air inlet 504 of Shimizu is similar to that of the Cote Provisional in that it consists of a tube entering a chamber beneath a group of filtration membranes from a horizontal direction, not from "above and through" a manifold as claimed. Thus, the air delivery system of Shimizu cannot render obvious the gas inlet recited in independent claim 1.

On page 25 of the Examiner's Answer, the Examiner asserts that "each of the membranes of Shimizu can be a module according to the definition of the module on page 8 of Applicant's specification" and appears to assert that Shimizu may thus disclose a "plurality of membrane filtration modules" supplied with gas from a single gas inlet. As discussed above with reference to the membrane module of Zha, however, Appellants' specification does not define a "module" in the manner asserted by the Examiner. Further, Shimizu discloses that a plurality of membrane cartridges 110 are included in a single membrane module 102 (Shimizu at page 6, lines 38-45). An individual membrane cartridge 110 cannot constitute a "module," and Shimizu fails to

disclose or suggest a "plurality of membrane filtration modules" supplied with gas from a single gas inlet as claimed.

ii. Claims 12, 35, 40, and 41

The Examiner does not separately address the rejection of any of independent claims 12, 35, 40, or 41 over Zha in view of Shimizu and further evidenced by Cote '308. These claims are patentable over this asserted combination of references for at least the same reasons given above as to why they are patentable over the asserted combination of the Cote Provisional and Zha.

2. Shimizu and Zha are not properly combinable *ab initio.*

The Examiner has failed to establish that Shimizu may be properly combined with Zha. The Examiner provides a conclusory statement, without supporting reasoning on page 14 of the Examiner's Answer that "It would also have been obvious to one of ordinary skill in the art at the time of the invention to use the teaching of Shimizu . . . in the teaching of Zha to have a wider gas distribution from a short-distance injection point and prevent any swirl generated by an upward injection." The Examiner does not, however, show or even assert that the venturi system of Zha would suffer from "swirl generated by an upward injection." Further, as discussed above, Zha discloses that air injection systems such as is disclosed in Shimizu are subject to various disadvantages which the Zha venturi system avoids. To replace the venturi system with the gas delivery system of Shimizu would alter the fundamental operating principle of the operation of Zha's venturi system and would negate the disclosed advantages of the system. Thus, there would have been no motivation for one of ordinary skill in the art to replace the venturi system of Zha with the air delivery system of Shimizu.

Accordingly, because each element of each of independent claims 1, 12, 35, 40, or 41 is nether disclosed nor suggested by the asserted combination of Zha in view of Shimizu and further evidenced by Cote '308, and because these references are not properly combinable *ab initio*, none of these claims, or the claims that depend therefrom, can be obvious over Zha in view of Shimizu and further evidenced by Cote '308.

C. Each of claims 1-3, 6, 9-14, 17, 20-22, 35, 40-48, and 54-56 is patentable over the asserted combination of Zha and/or Cote '308 in view of Shimizu and Henshaw

The Examiner relies on Henshaw for disclosing that a plurality of submerged membrane modules may be arranged in manifolds to have enlarged treatment systems. This teaching, however, does nothing to cure the failure of the asserted combination of any of Zha, Cote '308 (as supported by the Cote Provisional) or Shimizu, alone or in combination, to disclose or suggest each element of any of the claims of the present application as discussed above.

D. Summary

A close reading of Appellants' Appeal Brief and the Examiner's Answer reveals certain dispositive facts in dispute. For example, the Examiner continues to assert that Cote '038 (as supported by the Cote Provisional) and Shimizu are combinable with Zha such that it would have been obvious to replace the venturi-based air delivery system of Zha with the air delivery systems of either the Cote Provisional or of Shimizu. The Examiner ignores the fact that Zha specifically states that the disclosed venturi system has advantages over air delivery systems, such as disclosed in Cote or in Shimizu that would have dissuaded one of skill in the art from making such a combination. The Examiner also ignores the fact that such a combination would result in a fundamental alteration in the operating principle of the air delivery system of Zha, and thus cannot be obvious.

The Examiner fails to address that even if combined, the asserted references would fail to disclose or suggest numerous elements of the claims of the present application; for example, an air inlet configured to feed gas into an open-ended mixing chamber from above and through a manifold in which multiple filtration modules are mounted.

Further, the Examiner fails to recognize that a simple "replication" of the apparatus disclosed in any of the cited references could not result in the apparatus recited in any of the claims of the present invention.

In view of the above, each of the rejections is improper and should be reversed. Appellants respectfully request reversal of the rejections and issuance of a Notice of Allowance.

V. CLAIMS APPENDIX (37 C.F.R. § 41.37(c)(1)(viii))

1. (Previously Presented) A membrane filtration apparatus comprising:

a plurality of membrane filtration modules, each membrane filtration module comprising:

a plurality of porous membranes extending in an array, said plurality of porous membranes encased in a support structure and having lower ends mounted in a lower pot supported by a lower header and upper ends mounted in an upper pot supported by an upper header, said upper header configured to provide for permeate to be withdrawn from said upper ends of said plurality of porous membranes; and

a plurality of distribution apertures defined in said lower pot, said distribution apertures configured to distribute a scrubbing fluid into said module and along a surface or surfaces of said membranes;

a single manifold coupled to said lower header of each of said plurality of membrane filtration modules; and

a single chamber positioned below, and connected to, said manifold, said chamber constructed and arranged to promote upward flow of feed liquid therethrough, said chamber comprising:

an open base end in fluid communication with a source of feed liquid;

a second end in fluid communication with said distribution apertures; and

a single gas inlet constructed and arranged to introduce gas into said chamber in a downward direction from above the open base end, said gas fed from above and through said manifold and into said chamber, said gas inlet centered between at least two of said plurality of membrane filtration modules and configured to release gas into said chamber at a position vertically displaced below said at least two of said plurality of membrane filtration modules, said chamber configured to mix gas and liquid to produce said scrubbing fluid and further configured to distribute said scrubbing fluid to said distribution apertures.

2. (Previously Presented) The membrane filtration apparatus according to claim 1 wherein the chamber is elongate.

3. (Previously Presented) The membrane filtration apparatus according to claim 1 wherein the length of said chamber is greater than that required to provide a static head, when the membrane is immersed in a

liquid and gas introduced into the chamber, equivalent to the head loss for the gas to flow to said distribution apertures.

4. (Canceled)

5. (Canceled)

6. (Previously Presented) The membrane filtration apparatus according to claim 1 wherein the chamber is enclosed on all sides.

7. (Canceled)

8. (Canceled)

9. (Previously Presented) The membrane filtration apparatus according to claim 1 wherein the chamber comprises a plurality of sides positioned to form a skirt directly beneath a header or plurality of headers.

10. (Previously Presented) The membrane filtration apparatus according to claim 1 wherein said plurality of membrane filtration modules are arranged in the form of an extended linear array, and wherein the chamber has enclosed long sides.

11. (Previously Presented) The membrane filtration apparatus according to claim 10 wherein the chamber has unenclosed short sides.

12. (Previously Presented) An assembly of membrane modules comprising:

a plurality of porous membranes extending in an array and having lower ends mounted in a plurality of lower pots supported by a plurality of respective lower headers, and upper ends mounted in a plurality of upper pots supported by a plurality of respective upper headers, said lower pots being configured to provide a number of distribution apertures therein for distributing a scrubbing fluid into said assembly of membrane modules and along a surface or surfaces of said membranes, said lower headers coupled to a manifold; and

a chamber positioned below and connected to said manifold, said chamber constructed and arranged to promote upward flow of feed liquid therethrough, said chamber comprising:

an open base end in fluid communication with a source of feed liquid;

a second end in fluid communication with said distribution apertures; and

a gas inlet constructed and arranged to introduce gas into said chamber in a downward direction from above the open base end, said gas fed from above and through said manifold,

said chamber configured to mix gas and liquid to produce said scrubbing fluid and further configured to distribute said scrubbing fluid to said distribution apertures.

13. (Previously Presented) The assembly of membrane modules according to claim 12 wherein the chamber is elongate.

14. (Previously Presented) The assembly of membrane modules according to claim 12 wherein the length of said chamber is greater than that required to provide a static head, when the membrane is immersed in a liquid and gas introduced into the chamber, equivalent to the head loss for the gas to flow to said distribution apertures.

15. (Canceled)

16. (Canceled)

17. (Previously Presented) The assembly of membrane modules according to claim 12 wherein the chamber is enclosed on all sides.

18. (Canceled)

19. (Canceled)

20. (Previously Presented) The assembly of membrane modules according to claim 12 wherein the chamber comprises a plurality of sides positioned to form a skirt directly beneath a header or plurality of headers.

21. (Previously Presented) The assembly of membrane modules according to claim 12 when arranged in the form of an extended linear array wherein the chamber has enclosed long sides.

22. (Previously Presented) The assembly of membrane modules according to claim 12 in the form of an extended linear array wherein the chamber has unenclosed short sides.

23. (Withdrawn) A method of removing a fouling material from a plurality of porous hollow fiber membranes mounted and extending longitudinally in an array to form a membrane module, the method comprising the steps of: providing a source of gas to a chamber in fluid communication with said membrane module; flowing the gas from the chamber into a base of the membrane module to form gas bubbles therein when said module is immersed in a liquid, whereby an upward flow of the gas bubbles across surfaces of the hollow fiber membranes is obtained, and whereby fouling materials are dislodged from the surfaces of the porous hollow fiber membranes.

24. (Withdrawn) A method according to claim 23 wherein the source of gas to the chamber is provided within the chamber.

25. (Withdrawn) A method according to claim 23 wherein the source of gas to the chamber is provided from below the chamber.

26. (Withdrawn) A method according to claim 23 wherein said chamber is elongate with one end open and the other end in fluid communication with the membrane module.

27. (Withdrawn) A method according to claim 26 wherein the gas is provided through the open end of the chamber.

28. (Withdrawn) A method of removing a fouling material from a plurality of porous hollow fiber membranes mounted and extending longitudinally in an array to form a membrane module, the method comprising the steps of: forming a mixture of gas bubbles and liquid within a mixing chamber; injecting the mixture into a base of the membrane module, whereby an upward flow of the mixture across

surfaces of the hollow fiber membranes is obtained, and whereby fouling materials are dislodged from the surfaces of the porous hollow fiber membranes.

29. (Withdrawn) A method according to claim 28 wherein the step of forming a mixture comprises entraining the gas bubbles into a liquid stream.

30. (Withdrawn) A method according to claim 29 wherein the gas bubbles are entrained into said liquid stream by means of the chamber.

31. (Withdrawn) A method according to claim 29 wherein the gas bubbles are entrained or injected into said liquid stream by means of devices which forcibly mix gas into a liquid flow to produce a mixture of liquid and bubbles.

32. (Withdrawn) A method according to claim 23 wherein air entering the mixing chamber is deflected.

33. (Withdrawn) A method according to claim 32 wherein air entering the mixing chamber is deflected by way of a T-piece or baffle.

34. (Withdrawn) A method according to claim 32 wherein air entering the mixing chamber is deflected away from liquid entering the mixing chamber by way of a nozzle.

35. (Previously Presented) A membrane filtration apparatus comprising:

a plurality of membrane filtration modules, each membrane filtration module comprising a plurality of porous membranes, said membranes being arranged in close proximity to one another and having lower ends mounted in a lower pot supported by a lower header and upper ends mounted in an upper pot supported by an upper header, said upper header configured to provide for permeate to be withdrawn from said upper ends of said porous membranes;

a manifold coupled to said lower headers;

an open-ended mixing chamber constructed and arranged to provide a cleaning mixture by mixing together liquid and gas bubbles, said chamber immersed in a feed tank and having an open base

in fluid communication with a source of feed liquid, said chamber constructed and arranged to promote upward flow of feed liquid therethrough;

a gas source positioned within the open-ended mixing chamber, the gas source constructed and arranged to introduce gas through a single gas inlet into the open-ended mixing chamber in a downward direction from above the open base, said gas fed from above and through said manifold and into said chamber, said single gas inlet centered within said plurality of membrane modules; and

means for flowing said cleaning mixture along a surface of said membranes to dislodge fouling materials therefrom.

36. (Withdrawn) A method of removing fouling materials from the surface of a plurality of porous hollow fibre membranes mounted and extending longitudinally in an array to form a membrane module, said membranes being arranged in close proximity to one another, the method comprising the steps of forming a mixture of gas bubbles and liquid within a mixing chamber, said mixture being formed by said gas bubbles being entrained in said liquid by flowing said liquid past a source of gas so as to cause said gas to be drawn and/or mixed into said liquid, flowing said mixture into said membrane module such that said bubbles pass substantially uniformly between each membrane in said array to, in combination with said liquid flow, scour the surface of said membranes and remove accumulated solids from within the membrane module.

37. (Withdrawn) A method according to claim 36 wherein the membranes comprise porous hollow fibres, the fibres being fixed at each end in a header, the lower header having one or more holes formed therein through which mixture of gas/liquid is introduced from the mixing chamber.

38. (Withdrawn) A method according to claim 37 wherein the holes are circular, elliptical or in the form of a slot.

39. (Withdrawn) A method according to claim 36 wherein the membranes comprise porous hollow fibres, the fibres being fixed at each end in a plurality of headers, the lower headers being configured to provide a number of distribution apertures therebetween through which mixture of gas/liquid is introduced from the mixing chamber.

40. (Previously Presented) A membrane bioreactor comprising:

a plurality of membrane filtration modules, each membrane filtration module comprising a plurality of porous hollow membrane fibres extending longitudinally between and mounted between an upper and a lower potting head, said membrane fibres being arranged in close proximity to one another, said fibres being partitioned into a number of bundles at least at or adjacent to their respective potting head so as to form a space therebetween;

a header in which the lower potting head is supported;

a manifold coupled to the header;

an open-ended mixing chamber positioned below the lower potting head, said chamber constructed and arranged to promote upward flow of feed liquid therethrough, said chamber having an open base in fluid communication with a source of feed liquid; and

a gas inlet positioned within the open-ended mixing chamber, the gas inlet spaced from and surrounded by side walls of the open-ended mixing chamber and configured to feed gas into the open-ended mixing chamber from above and through said manifold,

wherein at least one of said potting heads includes an array of openings formed therein in fluid communication with said chamber constructed and arranged to provide gas bubbles within said module such that, in use, said bubbles move past the surfaces of said membrane fibres to dislodge fouling materials therefrom.

41. (Previously Presented) An assembly of membrane modules for use in a membrane bioreactor comprising:

a plurality of porous hollow membrane fibres extending longitudinally between and mounted between an upper and a lower potting head, said membrane fibres being arranged in close proximity to one another, said fibres being partitioned into a number of bundles at least at or adjacent to their respective potting head so as to form a space therebetween;

a header in which the lower potting head is supported;

a manifold coupled to the header;

an open-ended mixing chamber positioned below the lower potting head, said chamber constructed and arranged to promote upward flow of feed liquid therethrough, said chamber having an open base in fluid communication with a source of feed liquid; and

a gas inlet positioned within the open-ended mixing chamber, the gas inlet spaced from and surrounded by side walls of the open-ended mixing chamber, and centrally located within the open-ended mixing chamber and configured to feed gas into the open-ended mixing chamber from above and through said manifold;

wherein said potting heads are configured to provide a number of distribution apertures therebetween in fluid communication with said chamber for providing gas bubbles within said assembly of membrane modules such that, in use, said bubbles move past the surfaces of said membrane fibres to dislodge fouling materials therefrom.

42. (Previously Presented) The assembly of membrane modules according to claim 41 wherein the liquid used is feed to the membrane module.

43. (Previously Presented) The assembly of membrane modules according to claim 41 wherein the fibres within the module have a packing density of between about 5 to about 70%.

44. (Previously Presented) The assembly of membrane modules according to claim 43 wherein the packing density is between about 8 to about 55%.

45. (Previously Presented) The assembly of membrane modules according to claim 41 wherein said holes have a diameter in the range of about 1 to 40 mm.

46. (Previously Presented) The assembly of membrane modules according to claim 45 wherein said holes have a diameter in the range of about 1.5 to about 25 mm.

47. (Previously Presented) The assembly of membrane modules according to claim 41 comprising a deflector within said mixing chamber configured to deflect gas away from the source of the liquid.

48. (Previously Presented) The assembly of membrane modules according to claim 41 including a nozzle whereby liquid is introduced into the mixing chamber.

49. (Withdrawn) A membrane bioreactor comprising a tank having means for the introduction of feed

thereto, means for forming activated sludge within said tank, a membrane module or an assembly according to claim 41 positioned within said tank so as to be immersed in said sludge and said membrane module provided with means for withdrawing filtrate from at least one end of said fibre membranes.

50. (Withdrawn) A method of operating a membrane bioreactor of the type according to claim 49, comprising introducing feed to said tank, applying a vacuum to said fibres to withdraw filtrate therefrom while periodically or continuously supplying a cleaning mixture of gas bubbles and liquid formed in a mixing chamber through said openings to within said module such that, in use, said cleaning mixtures flows along the surface of said membrane fibres to dislodge fouling materials therefrom.

51. (Withdrawn) A membrane bioreactor according to claim 49 wherein a further source of aeration is provided within the tank to assist microorganism activity.

52. (Withdrawn) A membrane bioreactor according to claim 51 wherein the membrane module is suspended vertically within the tank and said further source of aeration is provided beneath the suspended module.

53. (Withdrawn) A membrane bioreactor according to claim 52 wherein the further source of aeration comprises a group of air permeable tube.

54. (Previously Presented) The membrane filtration apparatus of claim 1 wherein said gas inlet is fluidly connected to a source of gas within said chamber.

55. (Previously Presented) The membrane filtration apparatus of claim 54 wherein said source of gas is coupled to a gas line which runs through said header.

56. (Previously Presented) The assembly of membrane modules of claim 12 wherein said gas inlet runs through said header.

VI. CONCLUSION

For the reasons provided above, the rejections are improper and should be reversed. Appellant respectfully requests reversal of the rejections and issuance of a Notice of Allowance.

If there is any additional fee occasioned by this filing, including an extension fee that is not covered by an accompanying payment, please charge any deficiency to Deposit Account No. 50/2762, Ref. No. M2019-7027US.

Respectfully submitted,
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